

[0530] Based on these measurement results, a lift-off resist layer 153 is deposited on the multilayer film 151, paying attention to the width dimension C of the insensitive regions D and D measured through the micro track profile method.

[0531] Referring to FIG. 25, undercuts 153a and 153a are formed on the underside of the resist layer 153. The resist layer 153 serves as a mask for etching the insulator layer 152 in a later step. The resist layer 153 is adjusted to grow so that the bottom face of the insulator layer 152 fully covers the sensitive region E of the multilayer film 151 after the etching of the insulator layer 152. The undercuts 153a and 153a are chiefly formed above the insensitive regions D and D of the multilayer film 151. When the side walls of the resist layer 153 are inclined at an angle subsequent to the etching, the undercuts 153a and 153a may cut into the area above the sensitive region E by a slight depth to account for the inclined wall face.

[0532] In a manufacturing step shown in FIG. 26, both sides of each of the multilayer film 151 and the insulator layer 152 are etched away.

[0533] In a manufacturing step shown in FIG. 27, the insensitive regions D and D of the multilayer film 151 are exposed by etching away only the insulator layer 152 of  $\text{Al}_2\text{O}_3$  in an alkaline solution. The layers forming the multilayer film 151 are not dissolved into the alkaline solution. In the state shown in FIG. 27, the bottom face of the insulator layer 152 fully covers the sensitive region E of the multilayer film 151.

[0534] When the insulator layer 152 of  $\text{Al}_2\text{O}_3$  is etched in the alkaline solution, the side walls of the insulator layer 152 are respectively maintained parallel to the side walls of the multilayer film 151, and even after the etching process, the side walls of the insulator layer 152 and the side walls of the multilayer film 151 are maintained parallel to each other.

[0535] When the magnetoresistive-effect devices shown in FIG. 21 is manufactured, the protective layer is deposited on top of the multilayer film 151, and the insulator layer 152 and the resist layer 153 are successively formed on top of the protective layer. Subsequent to the manufacturing step shown in FIG. 27, the portions of the protective layer, which come just below the undercuts 153a and 153a of the resist layer 153, namely, the portions not covered with the insulator layer 152, are removed through an obliquely entering ion milling beam to expose the layer beneath the protective layer.

[0536] In a manufacturing step shown in FIG. 28, hard bias layers 154 and 154 are deposited on both sides of the multilayer film 151. In this invention, the sputtering technique, used to form the hard bias layers 154 and 154 and electrode layers 156 and 156 to be formed subsequent to the formation of the hard bias layers 154 and 154, is preferably at least one sputtering technique selected from an ion-beam sputtering method, a long-throw sputtering method, and a collimation sputtering method.

[0537] In accordance with the present invention, as shown in FIG. 28, a substrate 150 having the multilayer film 151 formed thereon is placed normal to a target 155 having the same composition as that of the hard bias layers 154 and 154. In this setup, the hard bias layers 154 and 154 are grown in a direction normal to the multilayer film 151 using the ion-beam sputtering method, for instance. Less sputter par-

ticles are deposited in the regions of the hard bias layers 154 and 154 in contact with the multilayer film 151, because of the overhang by both end portions of the resist layer 153. The thickness of the hard bias layers 154 and 154 is thinner in the regions thereof in contact with the multilayer film 151, and the top surface of the hard bias layers 154 and 154 are downwardly inclined or curved toward the multilayer film 151 as shown. Referring to FIG. 28, a layer 154a having the same composition as that of the hard bias layers 154 and 154 is deposited on top of the resist layer 153.

[0538] In the manufacturing step shown in FIG. 28, the hard bias layers 154 and 154 are preferably formed so that the height position of the top edge or the bottom edge (in the Z direction) of the magnetic coupling junction between the multilayer film 151 and each of the hard bias layers 154 and 154 is at the same level as the height position of the top surface or the bottom surface of the free magnetic layer or the magnetoresistive-effect layer in the direction of the advance of the recording medium.

[0539] It is sufficient if each of the hard bias layers 154 and 154 is magnetically coupled with the free magnetic layer only or the magnetoresistive-effect layer only. The influence of the magnetic field generated from the bias layers 154 and 154 on the magnetization direction of the pinned magnetic layer is controlled, if the hard bias layers 154 and 154 remain magnetically uncoupled with the pinned magnetic layer.

[0540] If the multilayer film 151 includes a free magnetic layer which is composed of a plurality of soft magnetic thin-film layers having different magnetic moments and separated from each other by nonmagnetic material layers, like the multilayer film of one of the thin-film devices shown in FIG. 20 through FIG. 23, the hard bias layers 154 and 154 are preferably formed so that the magnetic coupling junction between the multilayer film 151 and each of the hard bias layers 154 and 154 is fabricated of an interface with the end face of only one of the plurality of the soft magnetic thin films forming the free magnetic layer.

[0541] If the magnetic coupling junction between the multilayer film 151 and each of the hard bias layers 154 and 154 is fabricated of an interface with the end face of only one of the plurality of the soft magnetic thin-film layers forming the free magnetic layer, the magnetization direction of the soft magnetic thin-film layer on both end portions is free from disturbance.

[0542] In a manufacturing step shown in FIG. 29, the electrode layers 156 and 156 are obliquely grown on the hard bias layers 154 and 154 at an angle to the multilayer film 151. In this case, the electrode layers 156 and 156 are grown into the undercuts 153a and 154a formed on the underside of the resist layer 153 arranged on top of the multilayer film 151.

[0543] Referring to FIG. 29, the target 157 having the same composition as that of the electrode layer 156 is inclined at an angle to the substrate 150 having the multilayer film 151 formed thereon, and the electrode layers 156 and 156 are grown on the hard bias layers 154 and 154 using the ion-beam sputtering method while moving the target 157 transversely across the substrate 150. The electrode layers 156 and 156 sputtered at an angle to the multilayer film 151 are formed not only on the hard bias layers 154 and 154 but also into the undercuts 153a and 153a of the resist layer 153.